Early multidisciplinary research during the 2020 lockdown

University of Southampton, Global Network for Anti-Microbial Resistance and Infection Prevention

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In the early months of the COVID-19 pandemic, a great deal was unknown about the infection and disease and, with much of the country in lockdown, researchers and inventors were investigating ways to reduce the impact of the disease. These included the development of diagnostics, infection prevention tactics, therapeutics and public health measures. This article reports on activities that members of NAMRIP rapidly developed, on their own initiative, in response to the crisis, with a range of funding sources or none. Reporting on multiple teams means that word limits do not leave room for the full team and sponsor listings for each project and interested readers can consult the links herein.

Infection Prevention

In those early months, with vaccines a long way off, infection prevention was crucial, and yet much about the infection routes was not yet known. For workplaces in health and social care, research and essential services, and for the general public, there were different needs and prioritizations when it came to the provision of PPE and good information.

In April 2020, the PerSo team began designing a personal respirator prototype for frontline healthcare staff, freely sharing the design online, and, partnering with industry to make them commercially. Over 3,500 were used by staff at University Hospital Southampton during wave 2, all requested by staff. The full-head hood, with fan-driven air filtered and blown over the visor, was later adapted to designs that left the ears free to facilitate hearing (Figure 1). In June 2020 the Perso-DW (Developing World) team shipped 135 hoods to Ethiopia.

Respirators were also needed for those research labs, essential services and the general public, who did not have access to the PPE dedicated to frontline healthcare workers. One of our commercial partners, SWT, noticed that widely available builder's/mechanic's/DIY masks contained an airtight face-seal, lasted 28 days, filtered the in-breath, but were compromised by an exhalation valve that released potentially-infectious exhalations without filtration. SWT released files for free that anyone with a 3D-printer could download to add a filter to their exhalation-valve (Figure 2). A month later the US Centre for Disease Control released a warning against the use of masks as supplied by manufacturers (i.e. with only a simple, unfiltered exhalation valve).

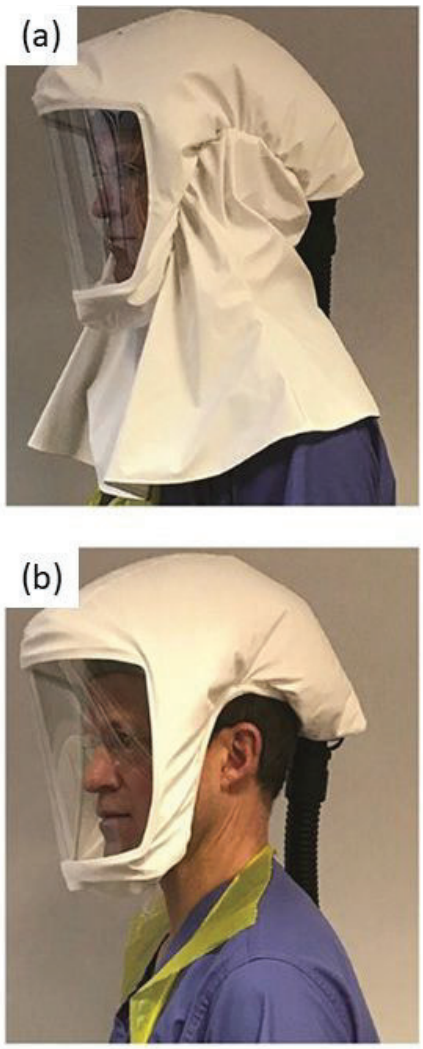

Figure 1. PeRSo variants with (a) a long hood type, and (b) short hood type that exposes the ears (adapted from Front. Med. Technol., 14 October 2021, https://doi.org/10.3389/fmedt.2021.729658).

Figure 2. The filer (black and white) attachment to the exhalation valve on a standard builder's/mechanic's respirator.

Figure 3. Prototype technology for the ultrasonic water tap.

SWT also produced (for the UK Government's Innovate-UK) prototypes of its ultrasonic water tap for cleaning respiratory secretions off, for example, intubation tubes (Figure 3). By the start of the pandemic, the Mapping Microbes collaboration of geographers, nurses, engineers and microbiologists had already been highly successful gathering data, and releasing movies for public and healthcare professionals, on infection routes via touch surfaces. During the pandemic they focused on infection routes on public transport, bringing together corporate, government and public stakeholders to identify issues, then publishing a report and series of short films (on 5 November 2021) to convey their findings to the public (Figure 4).

Before the pandemic, the 'Germ Defence' team had developed a website to encourage behaviour to reduce viral transmission. GermDefence is the only website worldwide proven to reduce infections in the home, and so in April 2020 the Germ Defence team released an update of their website to help combat COVID-19. With the aid of citizen science this was quickly translated

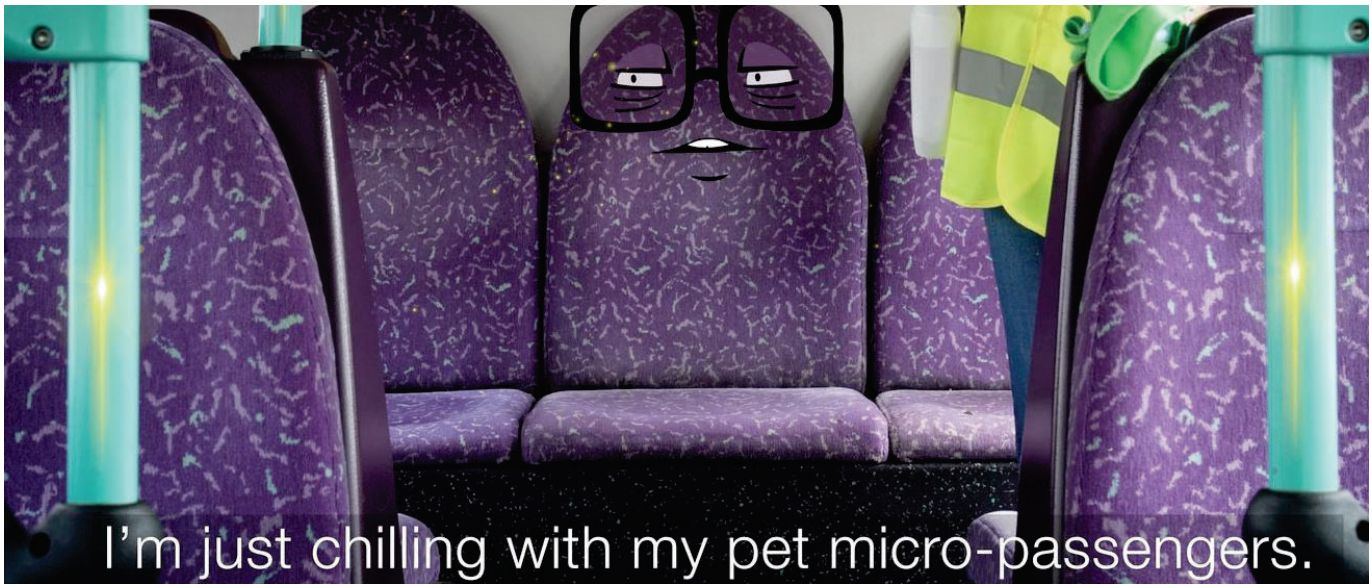

Figure 4. Video frame from film 1 of the 'You're never alone on the bus' series, ('Fresh air shows we are').

into 27 languages and used in 173 countries during the pandemic.

Diagnostics

At the onset of the pandemic, to explore faster options than traditional PCR tests provided at the time, a team from the University Hospital Southampton NHS Foundation Trust and the Faculty of Medicine took part in evaluations of two kits: FebriDx (a finger-prick blood test of 248 viable patients, tested 20 March and 12 April 2020, and published 20 June 2020) and QIAstat-Dx (a real-time polymerase chain reaction test of nose and throat swab samples from 499 viable patients, tested 20 March 20 to 29 April, and published 20 October 2020). Both of these point-of-care tests were subsequently rolled out as part of routine clinical care at University Hospitals Southampton.

The CERAbTc-19 (Clinical Evaluation of Rapid Antibody Test for Covid-19) team conducted a clinical evaluation of the accuracy and clinical usefulness of a rapid antibody test for COVID-19 in a drop of capillary blood, developed by a diagnostics company in China. Two groups of adult participants were recruited at Watford General Hospital, in two groups: (a) patients who had confirmed COVID-19 on PCR (from 5th March to 18th June 2020) and (b) hospital staff with history of clinically suspected COVID-19 (based on reported symptoms) who had a standard venous antibody test (from 1st May to 22nd July 2020), at least 7 days after onset of symptoms. The results were published on 18 November 2020 and 14 July 2021.

The Laser-Direct-Write Technologies for Biomedical Sensors Team at the Optoelectronics Research Centre were, by May 2020, exploring the development of the next-generation lateral flow tests using their laser-based fabrication process.

By June 2020 the Microguide app team had adapted their phone-based app (Figure 5) to combat the inappropriate use of antibiotics during the early days of the Covid-19 pandemic, which was resulting in a resurgence of antibiotic-resistant pathogens such as C. difficile in some UK hospitals. The app is licenced to over 70 NHS acute Trusts.

Public Health

In July 2020 the RTO-Covid-19 team launched a retrospective survey of prevention, treatment, occurrence and outcomes of Covid-19 in the community. They collected data on what behaviours people undertook, what symptoms they experienced, and what they did if they became infected.

Figure 5. The Microguide app.

The Tec-19 (Teenagers' Experiences of COVID-19) team researched the experience of teenagers in Low- and Middle-income Countries during the pandemic. Starting in August 2020, the aim was to understand how the pandemic was affecting the lives, mental health and well-being, and eating habits and physical activity behaviours of young people living in both rural and urban settings across sub-Saharan Africa (Ethiopia, Ghana, South Africa) and India. The hope was to progress to developing resources to support young people to maintain well-being, eat well, keep active and adhere to government guidelines during the pandemic.

Conclusion

Management of an outbreak of a known infectious disease is based on specific prevention (e.g. vaccination) and/or specific treatment. Management of novel infections always relies on interrupting the chain-of-transmission with non-specific measures, until more is known, and specific measures can be introduced. A reliable knowledge base reduces the uncertainties, but in its absence, ingenuity and a quick response are required. The activities in this article covered 2020, a time before vaccines were available, and when therapeutics were at an early stage.

Since 2000, more than 6 novel zoonoses have crossed species barriers from wild animals to humans (SARS, MERS, Ebola, Avian-flu, Swine-flu and SARS-CoV-2). It seems inevitable that further novel infections will emerge, and just because society has recent experience of one pandemic, it would be foolhardy for the public and lawmakers to assume the next novel infection will always use the same chain of transmission as did SARS-Cov-2. Airborne infections are particularly hazardous (Figures 1 and 2), and effective handwashing (as illustrated by Figure 3 and GermDefence) is useful against for most infections.

Even well-funded communities have a shortfall in the provision of infection prevention, compared to the need (note for example the frequent Norovirus outbreaks in the cruise industry). Multidisciplinary communities are a valuable tool to provide fast-response, and longer term, solutions.